SP-E1.5 Feather River Temperature Model Development

October 25, 2002

1.0 Introduction/Background

Temperatures in the Feather River downstream of the Fish Barrier Dam are very important for both agricultural interests and fishery habitat. Rice agriculture production requires temperatures that are warm enough for germination and growth. The fisheries that are supported within the Feather River downstream of the Oroville Reservoir require cooler temperatures for optimal habitat conditions. Analysis of operational alternatives that impact the temperature regime in the Feather River downstream of the Fish Barrier Dam will be very important in the relicensing process.

2.0 Study Objective

The goal of this study is to develop a temperature model for the Feather River downstream of the Fish Barrier Dam that can simulate water temperature from the Oroville Dam downstream through the area of influence of the river. Simulation of other water quality constituents such as DO and pH are not considered in the model development process. Initial co-ordination efforts have indicated that these issues are not of concern at this time.

If these issues become of concern later in the process the model developed under this study plan may not be appropriate for use and additional model development may be required.

3.0 Relationship to Relicensing /Need for the Study

In order for the Oroville facilities to obtain a new license the Federal Energy Regulatory Commission (FERC) requires water quality certification from the State Water Quality Control Board (SWRCB). The certification requires that SWRCB determine that the project complies with the water quality requirements of the Central Valley Water Resource Control Board (CVWRCB) Basin Plan (SPW1, 01). This study will enhance the information developed for FERC.

The purpose of this study is to develop a tool that can be used to evaluate the temperature impacts of engineering and operational alternatives and benchmark studies in the Feather River downstream of the Fish Barrier Dam. The temperatures in the Feather River downstream of the Fish Barrier Dam are very important for both the agricultural diversions for rice growth, and for the in-stream cold-water fishery.

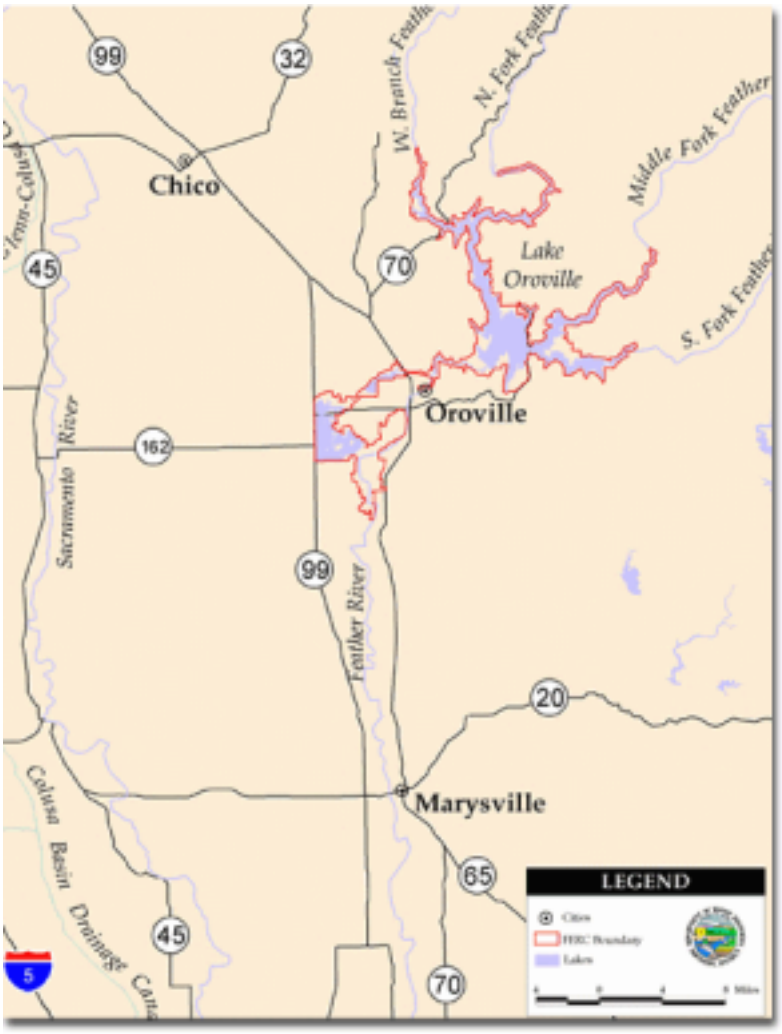
Engineering and Operations Issues Addressed

- E4—evaluate environmental and economic aspects of different flow regimes of Oroville Facilities operations. Factors to be considered include timing, magnitude and duration of flows, pump-back scheduling and maintenance scheduling, and hatchery operations.

- E6—effect of ramping rates on downstream facilities, power generation, water supply, water temperatures, and fish.
- E12—evaluate operational and engineering alternatives including selective withdrawal from Lake Oroville, Thermalito Afterbay, the hatchery, and the low flow section to meet various downstream temperature requirements
- E14—evaluate operational alternatives that balance and maintain acceptable water quality standards including those for MTBE under all operational plans and conditions

4.0 Study Area

The study area includes the Feather River downstream of the Fish Barrier Dam to its confluence with the Sacramento River. Geographic scope may be refined as additional information is developed and needs are identified through collaboration with other Work Groups.



5.0 General Approach

This study will evaluate potential models and tools that could be used to develop a temperature model of the Feather River downstream of the Fish Barrier Dam to its confluence with the Sacramento River. The resulting model will be capable of simulating temperatures throughout the Feather River.

Task 1—Define Desired Outputs from the Model

As currently formulated the required products from this model are hourly temperatures in the Feather River at various locations from the Fish Barrier Dam downstream to the confluence with the Sacramento River.

Additional desired outputs may be identified as the study plans from other work groups are completed and the process proceeds.

Task 2—Review Existing Models

There are at least two existing models that have potential for use as the Feather River temperature model known at this time, these are:

- **RMA-10** (Cook and Orlob, 2000) RMA-10 can be used as a one, two or three-dimensional finite-element, hydrodynamic and water quality modeling tool. A 1-D temperature model of the Feather River downstream of the Fish Barrier Dam to the confluence with the Sacramento River has been developed by UC Davis utilizing RMA-10. An empirical relationship between release flows and temperatures and water temperatures was developed for the Robison Riffle. Robinson riffle is a compliance point for the management of steelhead trout and spring run Chinook salmon, both federally listed species. This model operates on an hourly timestep and has been applied downstream of the Fish Barrier Dam to the Sacramento River.
- **HEC-5Q** (USACE-HEC 1987c), (Deas and Lowney, 2001) - The Corps of Engineers developed a daily time step model of the Sacramento River Basin, including the Feather River using the HEC-5Q modeling tool. The model was used for instructional purposes by the Corp in preparation of their Training Document 24. The HEC-5Q modeling tool used simulates a one-dimensional, vertical temperature distribution for reservoirs; and a one-dimensional, longitudinal distribution for rivers. Reservoir-river simulations can be processed in a single run and includes comprehensive operations logic to accommodate operations (e.g. flood control, hydropower production)
- **QUAL2E** (Deas and Lowney, 2001) - QUAL2E is a one-dimensional steady state flow model capable of simulating diurnal variations in water temperature. It operates on an hourly timestep and has been applied to the Feather River.

Task 3—Review Existing Data

Types of data required include:

- Solar radiation
- Dry and Wet bulb air temperatures
- Wind speed
- Atmospheric pressure
- Flow

Existing data identified at this time is listed in Attachments A and B.

Task 4—Review Modeling Tools

There are a number of modeling tools that may be appropriate for use to build a Feather River temperature model. The existing modeling tools include the following:

- **WQRRS** (USACE-HEC 1986), (Deas and Lowney, 2001)
    - Model was used on the North Fork of the Stanislaus River (Smith, 1981), and Shasta and Trinity reservoirs (Orlob et al. 1993) and Meyer and Orlob, 1994) to develop relationships between upstream reservoirs and downstream river temperature effects.
    - Developed by the ACE
    - Can also be used as a reservoir and river temperature model
    - Reservoir-river simulations must be processed separately
    - One-dimensional, vertical temperature distribution for reservoirs; one-dimensional, longitudinal distribution for rivers.
    - Hourly timestep
    - Includes broad range of water quality and ecological processes
- **RMA** (Deas and Lowney, 2001)
    - Versions 2 and 11 predict flow and temperature, respectively
    - This model generates hourly predictions
    - Both versions are one-dimensional
    - They model both reservoirs and streams
    - They have been applied to the Sacramento and Feather rivers, and Keswick reservoir (Deas et al., 1997, Jensen et al., 1999)
- **MIKE-11**
    - Simulates rivers and reservoirs
    - Dynamic, one dimensional
    - Consists of many modules for specific modeling simulations which can be run in conjunction or separately

Task 5—Select Appropriate Model or Modeling Tool

Based on the results of task 1 through 4 select the appropriate model/modeling tool to create the Feather River temperature model. The workgroup will approve the model/modeling tool selection. Oroville Reservoir Temperature Model. The workgroup will approve the model/modeling tool selection.

Task 6—Collect Field Data for Development/Calibration/Verification

Each model or modeling tool requires specific data for development/calibration/verification purposes. Once the model or modeling tool has been selected the specific data required to perform these tasks can be identified and compared to all known existing data to see if additional data is required to complete the model development.

Subtasks for this include:

- Identify additional data required
- Install instrumentation as required
- Collect data

Task 7—Complete Model Development/Calibration/Verification

This task is the actual development of the Feather River Temperature Model.

Subtasks include:

- Select model/modeling tool for use
- Identify additional required data including type of data, quality of data and locations for collection. Specify monitoring needs including instrumentation and data collection processes required to obtain the data.
- Develop physical system definition in model
- Develop time-series input data (hydrologic, operational)
- Begin model development with existing data. Use assumed values for additional required data until it is collected.
- Perform model modifications
- Calibrate/verify the model

The calibration/verification process will likely be the longest process involved in the study plan.

Task 8—Integrate Completed Model into Model Development Scheme

Integration of the model into the model development scheme will require development of the transfer utilities defined in Study #E1. These transfer utilities will be used for three main purposes:

- Extract data from the central modeling database, modify this data as required for input to the Feather River temperature model
- Extract data from the Feather River temperature model output files, perform any computation on them that may be required and store the results in the central modeling database
- Allow review of all data being transferred for quality control purposes

Task 9—Perform Benchmark Simulations

Perform the local operations modeling to provide the detailed benchmark simulations by performing the following actions:

- Get boundary conditions from central modeling database
- Use utility programs to create input based on the boundary conditions
- Perform the actual simulations
- Use utility programs to load data into central modeling database

The development will also be coordinated with study plans from other workgroups that will require evaluation of temperature impacts on Oroville releases.

6.0 Results and Products/Deliverables

Results

This study plan will result in a Feather River temperature model and benchmark studies for use in the process.

Products/Deliverables

There will be two products of this study plan:

- The product will be a Feather River temperature model that can simulate water temperatures at various locations within the Feather River downstream of the Fish Barrier Dam to its confluence with the Sacramento River. The model will be fully integrated into the overall modeling scheme.
- Simulated Feather River temperatures for the benchmark studies for use in other analysis.

7.0 Coordination and Implementation Strategy

Coordination with Other Resource Areas/Studies

This study will be coordinated with a number of other Engineering and Operation study plans:

- Study Plan #1—Model Development
- Study Plan #1b—Local Operations Model Development
- Study Plan #1c—Oroville Reservoir Temperature Model Development
- Study Plan #1d—Thermalito Complex Temperature Model Development
- Study Plan #2—Modeling Simulation
- Study Plan #6—Feather River Temperature Regime Analysis

Issues, Concerns, Comments Tracking and/or Regulatory Compliance Requirements

In order for the Oroville facilities to obtain a new license the Federal Energy Regulatory Commission (FERC) requires water quality certification from the State Water Quality Control Board (SWRCB). The certification requires that SWRCB determine that the project complies with the temperature requirements of the Central Valley Water Resource Control Board (CVWRCB) Basin Plan (SPW1, 01). This study will enhance the information developed for FERC.

8.0 Study Schedule

This section to be developed.

9.0 References

Cook, C. B. and G.T. Orlob. 2000. DRAFT. *Numerical Estimation of Dynamic Water Temperature at Compliance Point Robinson Riffle.* UC Davis Feather River Computational Model. May 2000

Deas M.L. and C.L. Lowney, 2001. Bay Delta modeling forum water temperature modeling review Central Valley. BDMF Temperature Review DRAFT.

United States Army Corp of Engineers – Hydrologic Engineering Center (USACE-HEC) 1987c. *Simulation of flood control and conservation systems: appendix on water quality analysis.* September

Attachment A
State Water Project Operation Data

	Location	Data Description	Data Description 2	Units	Data Type	Start Date	End Date	Data Source
1	Lake Oroville	Water Surface Elevation		Feet	Daily	Jan-90	Present	SWP
2	Lake Oroville	Storage		Acre-Feet	Daily	Jan-90	Present	SWP
3	Lake Oroville	Storage Change		Acre-Feet	Daily	Jan-90	Present	SWP
4	Lake Oroville	Outflow	Hyatt Powerplant	Acre-Feet	Daily	Jan-90	Present	SWP
5	Lake Oroville	Outflow	Palermo Canal	Acre-Feet	Daily	Jan-90	Present	SWP
6	Lake Oroville	Outflow	Evaporation	Acre-Feet	Daily	Jan-90	Present	SWP
7	Lake Oroville	Outflow	Spill	Acre-Feet	Daily	Jan-90	Present	SWP
8	Lake Oroville	Outflow	Total Outflow	Acre-Feet	Daily	Jan-90	Present	SWP
9	Lake Oroville	Inflow	Hyatt Powerplant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
10	Lake Oroville	Inflow	Computed Inflow	Acre-Feet	Daily	Jan-90	Present	SWP
11	Thermalito Forebay	Storage		Acre-Feet	Daily	Jan-90	Present	SWP
12	Thermalito Forebay	Storage Change		Acre-Feet	Daily	Jan-90	Present	SWP
13	Thermalito Forebay	Inflow	Lake Oroville Releases	Acre-Feet	Daily	Jan-90	Present	SWP
14	Thermalito Forebay	Inflow	Kelly Ridge Generation	Acre-Feet	Daily	Jan-90	Present	SWP
15	Thermalito Forebay	Inflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
16	Thermalito Forebay	Outflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
17	Thermalito Forebay	Outflow	Butte County	Acre-Feet	Daily	Jan-90	Present	SWP
18	Thermalito Forebay	Outflow	Thermalito Irrigation District	Acre-Feet	Daily	Jan-90	Present	SWP
19	Thermalito Forebay	Outflow	Releases to River	Acre-Feet	Daily	Jan-90	Present	SWP
20	Thermalito Forebay	Outflow	Hyatt Powerplant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
21	Thermalito Forebay	Losses and Gains		Acre-Feet	Daily	Jan-90	Present	SWP
22	Thermalito Afterbay	Water Surface Elevation		Feet	Daily	Jan-90	Present	SWP
23	Thermalito Afterbay	Storage		Acre-Feet	Daily	Jan-90	Present	SWP
24	Thermalito Afterbay	Storage Change		Acre-Feet	Daily	Jan-90	Present	SWP
25	Thermalito Afterbay	Inflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
26	Thermalito Afterbay	Outflow	Sutter Butte Canal	Acre-Feet	Daily	Jan-90	Present	SWP
27	Thermalito Afterbay	Outflow	Western Canal Lateral	Acre-Feet	Daily	Jan-90	Present	SWP
28	Thermalito Afterbay	Outflow	Richvale Canal	Acre-Feet	Daily	Jan-90	Present	SWP
29	Thermalito Afterbay	Outflow	Western Canal	Acre-Feet	Daily	Jan-90	Present	SWP
30	Thermalito Afterbay	Outflow	Afterbay River Outlet	Acre-Feet	Daily	Jan-90	Present	SWP

	Location	Data Description	Data Description 2	Units	Data Type	Start Date	End Date	Data Source
31	Thermalito Afterbay	Outflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
32	Thermalito Afterbay	Losses and Gains		Acre-Feet	Daily	Jan-90	Present	SWP
33	Thermalito Afterbay	Total Releases to River		Acre-Feet	Daily	Jan-90	Present	SWP
34	Oroville-Thermalito Complex	Mean Daily Water Temperature	Thermalito Afterbay Outlet	Fahrenheit	Daily	Jan-90	Present	SWP
35	Oroville-Thermalito Complex	Mean Daily Water Temperature	Fish Hatchery	Fahrenheit	Daily	Jan-90	Present	SWP
36	Oroville-Thermalito Complex	Lake Oroville Temperature Profile	Graph of Temp by Elevation	Fahrenheit/Feet	Daily	Jan-90	Present	SWP
37	Oroville and Delta Field Divisions Energy Data	Oroville-Thermalito Complex	Generation	KWH	Daily	Jan-90	Present	SWP
38	Oroville and Delta Field Divisions Energy Data	Oroville-Thermalito Complex	Load	KWH	Daily	Jan-90	Present	SWP
39	Oroville and Delta Field Divisions Energy Data	Baker Slough Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP
40	Oroville and Delta Field Divisions Energy Data	Cordelia Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP
41	Oroville and Delta Field Divisions Energy Data	Banks Pumping Plant	Total Load	KWH	Daily	Jan-90	Present	SWP
42	Oroville and Delta Field Divisions Energy Data		SWP Load	KWH	Daily	Jan-90	Present	SWP
43	Oroville and Delta Field Divisions Energy Data	South Bay Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP
44	Oroville and Delta Field Divisions Energy Data	Del Valle Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP

Attachment B
California Data Exchange Center

Ensor	Data Description	Data Type	Start Date	End Date	Station	Hydrologic Area
1	RIVER STAGE (feet)	(event)	9/10/1997	present	FEATHER RIVER AT BOYD'S LANDING (FBL)	
1	RIVER STAGE (feet)	(event)	9/10/1997	present	FEATHER RIVER AT LIVE OAK (FLO)	
1	RIVER STAGE (feet)	(event)	2/23/1995	present	FEATHER RIVER AT YUBA CITY (YUB)	
1	RIVER STAGE (feet)	(event)	1/5/1999	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
1	RIVER STAGE (feet)	(event)	2/23/1995	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
1	RIVER STAGE (feet)	(event)	2/10/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
1	RIVER STAGE (feet)	(hourly)	10/7/1997	present	FEATHER RIVER AT LIVE OAK (FLO)	
1	RIVER STAGE (feet)	(hourly)	1/5/1984	present	FEATHER RIVER AT MERRIMAC (MER)	
1	RIVER STAGE (feet)	(hourly)	1/1/1984	present	FEATHER RIVER AT YUBA CITY (YUB)	
1	RIVER STAGE (feet)	(hourly)	1/1/1984	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
1	RIVER STAGE (feet)	(hourly)	1/1/1984	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
1	RIVER STAGE (feet)	(hourly)	3/18/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
2	PRECIPITATION, ACCUMULATED (inches)	(hourly)	1/1/1984	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
2	PRECIPITATION, ACCUMULATED (inches)	(monthly)	10/1/1962	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
2	PRECIPITATION, ACCUMULATED (inches)	(monthly)	10/1/1989	5/1/1994	OROVILLE FISH HATCH. (ORF)	
2	PRECIPITATION, ACCUMULATED (inches)	(monthly)	10/1/1939	9/1/1991	OROVILLE RS (ORS)	
3	SNOW, WATER CONTENT (inches)	(monthly)	4/1/1930	present	FEATHER RIVER MEADOW (FEM)	
6	RESERVOIR ELEVATION (feet)	(daily)	2/14/1985	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
6	RESERVOIR ELEVATION (feet)	(hourly)	1/1/1984	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
7	RESERVOIR, SCHEDULED RELEASE (cfs)	(event)	10/1/1995	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
8	FULL NATURAL FLOW (cfs)	(daily)	4/21/1985	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
14	BATTERY VOLTAGE (volts)	(event)	7/31/2000	present	FEATHER RIVER AT MILE 61.6 (FRA)	
14	BATTERY VOLTAGE (volts)	(event)	2/23/1995	present	FEATHER RIVER AT YUBA CITY (YUB)	
14	BATTERY VOLTAGE (volts)	(event)	1/5/1999	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
14	BATTERY VOLTAGE (volts)	(event)	2/23/1995	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
14	BATTERY VOLTAGE (volts)	(hourly)	10/7/1997	present	FEATHER RIVER AT LIVE OAK (FLO)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER AT MERRIMAC (MER)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER AT YUBA CITY (YUB)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
14	BATTERY VOLTAGE (volts)	(hourly)	2/19/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER

Ensor	Data Description	Data Type	Start Date	End Date	Station	Hydrologic Area
15	RESERVOIR STORAGE (af)	(daily)	2/13/1985	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
15	RESERVOIR STORAGE (af)	(daily)	1/1/1985	present	THERMALITO AFTERBAY (TAB)	
15	RESERVOIR STORAGE (af)	(hourly)	1/1/1984	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1967	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1967	present	THERMALITO AFTERBAY (TAB)	
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1969	present	THERMALITO DIVERS POOL (THD)	
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1969	present	THERMALITO FOREBAY (TFR)	
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1969	present	THERMALITO TOTAL (TMT)	
20	FLOW, RIVER DISCHARGE (cfs)	(event)	1/5/1999	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
20	FLOW, RIVER DISCHARGE (cfs)	(event)	2/10/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
20	FLOW, RIVER DISCHARGE (cfs)	(hourly)	1/5/1984	present	FEATHER RIVER AT MERRIMAC (MER)	
20	FLOW, RIVER DISCHARGE (cfs)	(hourly)	1/1/1984	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
20	FLOW, RIVER DISCHARGE (cfs)	(hourly)	3/18/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
22	RESERVOIR, STORAGE CHANGE (af)	(daily)	10/1/1993	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
23	RESERVOIR OUTFLOW (cfs)	(daily)	1/5/1987	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
23	RESERVOIR OUTFLOW (cfs)	(hourly)	2/6/1998	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
25	TEMPERATURE, WATER (deg f)	(event)	7/31/2000	present	FEATHER RIVER AT MILE 61.6 (FRA)	
41	FLOW, MEAN DAILY (cfs)	(daily)	1/1/1993	present	FEATHER RIVER AT MERRIMAC (MER)	
41	FLOW, MEAN DAILY (cfs)	(daily)	1/1/1993	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
45	PRECIPITATION, INCREMENTAL (inches)	(daily)	1/1/1987	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1925	8/1/1992	FEATHER MF NR CLIO (FTC)	
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1907	9/1/1970	FEATHER MF NR MERRIMAC (FTM)	
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1911	9/1/1995	FEATHER NF AT PULGA (FPL)	
65	FLOW, FULL NATURAL (af)	(monthly)	2/1/1905	9/1/1992	FEATHER NF NEAR PRATTVILLE (FPR)	
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1905	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1900	9/1/1992	FEATHER SF AT PONDEROSA (FTP)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1925	10/1/1925	FEATHER MF NR CLIO (FTC)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1907	10/1/1907	FEATHER MF NR MERRIMAC (FTM)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1911	10/1/1911	FEATHER NF AT PULGA (FPL)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	1/1/1905	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1900	10/1/1900	FEATHER SF AT PONDEROSA (FTP)	
68	EVAPORATION, LAKE COMPUTED (af)	(monthly)	10/1/1985	present	OROVILL-THERMALITO (ORT)	
69	FLOW, CANAL DIVERSION (AF) (af)	(monthly)	10/1/1985	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER
69	FLOW, CANAL DIVERSION (AF) (af)	(monthly)	3/1/1995	present	FEATHER RIVER(TRUCKE (FTT)	
69	FLOW, CANAL DIVERSION (AF) (af)	(monthly)	10/1/1985	present	THERMALITO FOREBAY (TFR)	
72	FLOW, IRRIG&CONSUMPTION (AF) (af)	(monthly)	10/1/1911	10/1/1911	FEATHER NF AT PULGA (FPL)	
74	EVAPORATION, LAKE COMPUTED (cfs)	(daily)	10/1/1994	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER

Ensor	Data Description	Data Type	Start Date	End Date	Station	Hydrologic Area
76	RESERVOIR INFLOW (cfs)	(daily)	1/1/1994	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
76	RESERVOIR INFLOW (cfs)	(hourly)	1/23/1997	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
85	DISCHARGE,CONTROL REGULATING (cfs)	(daily)	9/21/1999	present	TOTAL RELEASE-FEATHER R BLW THERMALITO (THA)	
85	DISCHARGE,CONTROL REGULATING (cfs)	(hourly)	2/5/1998	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
85	DISCHARGE,CONTROL REGULATING (cfs)	(hourly)	2/5/1998	present	TOTAL RELEASE-FEATHER R BLW THERMALITO (THA)	
94	RESERVOIR, TOP CONSERV STORAGE (af)	(daily)	10/20/2000	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
110	FLOW, CANAL DIVERSION (CFS) (cfs)	(daily)	3/1/2001	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER